[ABSTRACTS OF PAPERS.]

RESEARCHES INTO THE PHENOMENA OF RESPIRATION.

BY

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ROYAL SOCIETY.

January 20th, 1859.

Sir Benjamin Brodie, Bart., President, in the Chair.

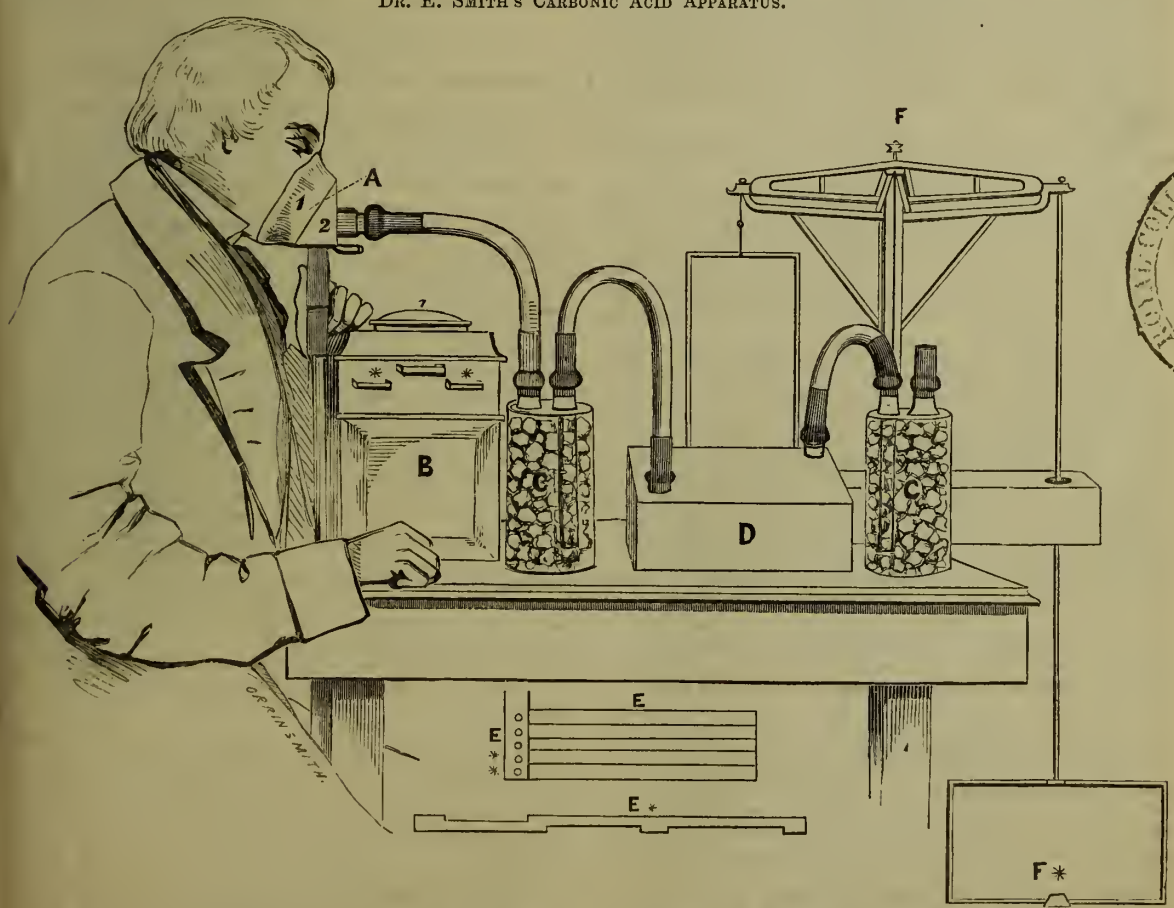
EXPERIMENTS ON SOME OF THE PHENOMENA OF RESPIRATION.

BY E. SMITH, M.D., LL.B.

The Apparatus which the author has employed in all his experiments may be described as follows:—There is, first, a Mask (A) which covers the nose, mouth, and chin, connected by a caoutchouc tube with a small spirometer (B), which measures and registers the air inspired. The mask fits the features so closely that no air can enter the mouth except through the spirometer; and it is composed of tolerably thick sheet lead, lined with sheet India rubber. There are valves so arranged that the expired air cannot pass back into the spirometer, but is directed through other tubes into the analytical apparatus; and, during inspiration, this expired air cannot re-enter the mask. Hence all the air which enters the mask is inspired, and none is respired twice. The Spirometer is a small one-light dry gas-meter, of improved manufacture, and registers from one to a million cubic inches. The motor power being the inspiration, it is that of a suction, and not a forcing pump; and hence the spirometer moves in a reverse manner from that which occurs when it is used as a gas-meter. (It will be observed, that it is not a *gas-holder*, such as Hutchinson's spirometer, but a *gas-meter;* and, by frequent testing, it was found to register with uniform accuracy.)

There is also an Analytical Apparatus, in which the carbonic acid is absorbed by caustic potass. This has two peculiarities, viz., that the expired air does not pass *into*, but only *over* the solution of potass, so that no impediment is offered to free expiration; and that the whole of the carbonic acid is absorbed during the period of expiration. Hence, when the experiment is over, the carbonic acid can be immediately weighed in one of Oertling's balances, which weigh to the one-hundredth of a grain with seven pounds in each pan; and the experiment can be renewed in a very few minutes. The apparatus consists of three parts: *first*, a desiccator of sulphuric acid and pumice stone (C), of a capacity of seventy cubic inches, into which the expired air is immediately received from the mask, and from which the dry air is passed into a potass-box (D), which is the *second* and the novel part of the apparatus. This is made of gutta percha, one-eighth to one-tenth of an inch thick, with dimensions of 12 in. × 12 in. × 5 inches, the edges being well fastened together by the hot iron, and by a sealing of strips of gutta percha melted and fixed upon the joints by the hot iron. There are five chambers (E), each occupying the whole superficies of the box, and five-eighths of an inch in depth; and, being placed over each other, there is a communication from one to the other by an opening somewhat larger than the area of the trachea. Around this opening, on the upper surface of each floor, is a ring of gutta percha, one-fourth of an inch in depth, to prevent the fluid lying upon each floor from passing through into the chambers beneath. Each chamber is subdivided, by strips of gutta percha (E*), into six cells. The strips are fastened by the hot iron to both the floors, and are made imperfect in the lower edge, so as to allow the fluid to pass freely over the whole chamber, and also at the upper edge at each end alternately, so as to permit the column of air to traverse the cells one after another, and therefore in two directions al-

Dr. E. Smith's Carbonic Acid Apparatus.



A. Mask. 1. Tolerably thick sheet lead to be moulded to the features. 2. Brass part to support the valves and tubes.
B. Spirometer. 1. Index. ** Loops for knapsack strape.
C C. Desiccators containing sulphuric acid and pumice-stone.
D. Potass-box, with five chambers, as shewn in section E.
E **. Tubes, with holes, inserted in the corner of the box, through which the fluid is introduced and removed. The openings are closed by turning the inner tube half round.
E. Partition in the chambers of the potass-box.
F. Oertling's balance, with long arm and pan. F* to receive the potass-box.

ternately, and at length to be passed through the opening in the floor to the chamber above. There are thus five chambers, having a total superficies of upwards of seven hundred inches, which communicate with each other, into each of which the fluid potass is passed by means of gutta percha tubes three-eighths of an inch in diameter, or by two sliding tubes, as represented in (E**). Thirty fluid-ounces of solution of caustic potass, of specific gravity 1·27, are introduced, and are found by experiment to absorb upwards of six hundred grains of carbonic acid, without permitting the smallest trace to pass over, as tested by baryta water. The expired air is passed to the bottom chamber by a gutta percha tube (E**), of the size of the trachea; and, having passed through each cell of each chamber in succession, escapes from the upper chamber, and is carried to the third part of the apparatus. The tubes are closed with corks when the potass has been introduced, and the corks are not removed until the contained potass must be discharged and replaced. The same potass may be allowed to remain in the box for many days; and the box itself, after having been used for more than twelve months, will still be uninjured by the fluid, provided it was at first very securely made; but, should a leak have occurred, the surface must be neutralised with acid before the hot iron will again secure it. The *third* part of the apparatus is a desiccator (c) similar to the first, which absorbs the watery vapour which the dried expired air had carried off from the fluid potass. The addition to the weight of the first drying apparatus with the mask and tubes gives the amount of vapour in the known volume of expired air, and the increase in weight of the second and third parts of the apparatus gives the amount of carbonic acid in the expired air. When the expired air is passed with the rapidity of ordinary expiration, this apparatus is sufficient; but when the rapidity is increased, as in voluntary efforts or during exertion, it is needful to use a double set. When, during a continuous experiment, it is desirable to weigh the carbonic acid at intervals, this may be effected by having two sets of the apparatus, since one may then be detached from the mask, and another be attached, without the loss of an expiration. The apparatus, including even the balances, is portable, and may be placed in two boxes, and carried to any distance without injury.

The author in this paper described the quantity of carbonic acid exhaled, and of air inhaled, with the rate of respiration and pulsation during the whole day and night at rest; also the variations of the day, with and without food and exertion; and those occurring from day to day and season to season. The peculiarities of his method of inquiry are—1. The collection of the whole of the carbonic acid evolved in the above conditions; and 2. The continuance of an experiment during the whole day, or its repetition at short and regular intervals during that period.

The total quantity of carbonic acid exhaled in the twenty-four hours was determined on four gentlemen in eight experiments, some of which were continued for eighteen hours, with short intervals for meals only, and others were made at the beginning of each hour and half-hour during that period. The quantity of carbonic acid exhaled in the six hours of the night was 1950 grains, and the total amount of carbon exhaled in the twenty-four hours at rest, varied as follows in the persons experimented on: in a person aged 39, 7·85 ounces avoirdupois; in a person aged 48, 6·768 ounces; in a person aged 27, 6·536 ounces; in a person aged 36, 5·676 ounces; or a total average, in eight experiments, of 7·144 ounces. The effect of walking at two and three miles per hour was found to be equal to 1 4-5th and 2 3-5th times that of rest; and, by making a computation of the amount of exertion made by different classes of the community, he found that in the non-laborious class the carbon was increased from 7·144 ounces to 8·68 ounces, and in the laborious class to 12·19 ounces daily. These quantities were contrasted with those obtained by previous observers. During profound sleep, the amount was reduced one-half from that of the average of the day, and increased gradually after 3 P.M. The variations during the day with food were so great that the maximum was one-half more than the minimum, the greatest occurring after each meal, but particularly after breakfast and tea, and the least immediately before the meals. During a fast of twenty-seven hours, the minimum quantity was maintained almost without change during the whole period whilst awake, and the quantity of carbon evolved in twenty-four hours without food was 5·923 ounces, instead of 7·84 ounces with food—a quantity equal to that in 20 ounces of bread. The blood and the excretions became very alkaline. The variations from day to day were due to temperature and the state of the system. Sudden increase of temperature caused a sudden decline in the respiratory changes, which continued until the temperature fell. This was an ever-acting cause of variation, but was the greatest after the cold of the winter. The state of the system caused by changes in the proportion of want and supply varied the quantity of carbonic acid evolved on the following morning. A good night's rest, a feeling of health, good supply of food, and not too much exertion, gave an increase on the following morning (therefore there was usually a high state of system on Monday), and the reverse under the contrary conditions. As these conditions vary from day to day, the amount of carbonic acid evolved varies every day. The variations which were due to seasons are very remarkable and important, since it was shown that the respiratory changes vary from season to season in a definite and periodic manner, so that the greatest changes occurred in the cold seasons, and the least in the hot seasons, and with definite periods at which this variation begins.

Dr. Smith also showed the amount of carbonic acid evolved with the exertion of the treadwheel.

All the above results were delineated upon an extensive series of diagrams.

Professors Williamson and Frankland bore testimony to the great accuracy of the method employed by Dr. Smith in a chemical point of view, the latter distinguished chemist stating that, having been himself one of the subjects of experiment for a whole day, he was convinced that the determination of the amount of carbonic acid was at least as accurate as could be obtained by the chemist in the laboratory when operating upon small quantities. Dr. Frankland also bore testimony to the very laborious nature of the inquiry.

ROYAL MEDICAL AND CHIRURGICAL SOCIETY.

Tuesday, February 22nd, 1859.

Sir Charles Locock, Bart., M.D., President, in the Chair.

SOME OF THE CYCLICAL CHANGES IN THE HUMAN SYSTEM CONNECTED WITH SEASON. BY EDWARD SMITH, M.D., LL.B.

Dr. Smith had occupied the last four years in determining the cyclical changes in the respiratory function, and referred to the two papers already published by him in the *Transactions* of the Society, and to very recent researches into the quantity of carbonic acid expired, and of air inspired, with the rate of pulsation and respiration in the cycle of the twenty-four hours, and then showed that the daily cycle is not the same at all times, but varies from day to day and month to month through the cycle of the seasons. He showed from the literature of the subject that, while the cyclical changes in any of the functions of the body had not been hitherto investigated, a large amount of knowledge had been gained in reference to respiration, but which was lacking in extent and demonstration. He particularly quoted the results obtained by Mr. Milner, surgeon to the Wakefield Convict Prison, which showed that the prisoners gain weight from April to October, and lose weight in the other months of the year. The author had made experiments upon himself, aged 39, and upon Mr. Moul, a gentleman aged 48, and had continued them upon himself from March 31, 1858 to the present time. Both gentlemen were without hereditary or acquired disease, in robust health, capable of, and accustomed to much mental and bodily exertion, above the middle height, and of very regular and moderate habits. The author takes every kind of food heartily, while Mr. Moul dislikes many. The time of experiment was from 7 to 8 A.M. before breakfast, with the body sitting and in perfect rest. His apparatus and method were then described and exhibited (see p. 253). The results of the experiments showed that as the season advanced from spring to the end of summer all the above-mentioned respiratory phenomena declined. The highest period was in the spring, the decline occurred at the beginning of summer, the lowest period was the end of summer, and the period of increase was the autumn. The extreme difference in the author was 30 per cent. in carbonic acid from the beginning of June to the beginning of September, and on the average of a month to the middle of August, was 17 per cent. in the carbonic acid, 30 per cent. in the air, and 32 per cent. in the rate of respiration. In Mr. Moul the loss at the middle of June was 27 per cent. in the carbonic acid and the air, and 28 per cent. in the rate. The author bears heat well, while Mr. Moul suffers much from it, and the results bear out a former observation

by the author, viz. that those who bear heat badly have an excess of all the seasonal changes. The author then arranged the months according to these seasonal changes, and showed that there are two tolerably fixed periods (maximum and minimum), and two periods of change (increasing and decreasing), and tabulated them as follows:—

Fixed ..	Maximum.—Jan. Feb. March, April, and May (sometimes Dec.)	
	Minimum.—July, August, part of Sept.	
Variable	Decreasing.—June (sometimes May.)	
	Increasing.—Oct. Nov. Dec. (sometimes Sept.)	

He then showed the relation which these changes have to temperature, pressure of the atmosphere, and vapour in the air, and proved that the latter do not altogether account for them. The relation of temperature and pressure is an inverse one, and the former is very marked in sudden accessions, and is therefore a frequent cause of variation; but a medium degree of temperature, as 55° to 60°, and a medium height of the barometer, as 29 to 30 inches, are accompanied by all the degrees of respiratory change. He then quoted Barrall's experiments, showing the influence of season upon the ingesta and egesta, both of carbon and nitrogen, to prove that within certain limits variations in the amount of carbon exhaled indicate also similar variations in the nitrogen excreted. He also showed that as the skin had exhaled in July only six grains of carbonic acid per hour, in experiments upon himself, it was not important for him to refer to it. The author then applied this discovery to the production of disease, and showed that the dangers of the fixed periods are from excess in both directions, *i.e.* excess and defect, and increase with the duration; while those of the variable periods result from the want of ready adaptation of the system to the variation of the external influences, and particularly of temperature and food, and would be the greatest at the commencement. He had abstracted the deaths in each season in the five non-epidemic years in London (1850-4) from diseases having periods of seasonal increase, and determined the excess or defect in each quarter of the year from that which would have occurred if the deaths had been equally distributed over the year, and showed that there was a close correspondence between the states of the human system at different seasons and the type of disease then prevalent. Thus diarrhœa, cholera, plague, yellow fever, and asthenic diseases, with diseases of the bowels, prevail with the decreasing and lowest states of system, while diseases of the lungs and sthenic diseases, prevail with the maximum state. He also showed, further, that the advancing type of disease is that of the advancing season, so that in epidemics of scarlatina occurring after the minimum period the most asthenic type is observed at first, while in measles occurring with or after the maximum period, the most inflammatory cases occur early. Scarlatina is checked by the increasing state of the system and measles by the decreasing. Hence in every disease it is important to bear in mind the season of the year as indicative of the state of the human system, and in every epidemic it is necessary to consider the nature of the advancing season. The author had also investigated (by the kindness of the Registrar-General and Dr. Farr) the viability of children born at different seasons in reference to the period of procreation and of birth, the former illustrating the state of system in the parents, and the latter in the child, and found that it referred only to the latter. Of all the children who died under the age of one year in the northern district, from Newcastle to Kendal, in 1857, and whose age in months was recorded, the largest percentage was born in the summer months, the period of decreasing and minimum vital action of the human system. Animals which procreate once a-year have their sexual appetites excited in the hot season, but they bring forth their young in the cold season.

The author concluded the paper, with four following deductions:—

1. Seasonal diseases must now be referred directly to the state of the system, and only indirectly to meteorological conditions. This does not affect the fashionable search after poisons.

2. The type of a seasonal disease varies with the advancing season.

3. The cyclical rotation of the seasonal changes in the system explains in great part the cessation of seasonal diseases; for while such diseases may increase as the state of system increases in which they arise, they must decline and cease as the state of system changes into its opposite. This was illustrated by comparing the march of a cholera epidemic from June to November, with the variations then proceeding in the system, and also the cessation of an epidemic of scarlatina and measles.

4. These cyclical changes are a part of the *vis medicatrix naturæ*.

The author having thus proved the great importance to health of this rotation of changes, exposed the folly of endeavouring to maintain in our hopitals, public offices, and houses, an unvarying condition throughout the year, and stated that the contrary plan had been of incalculable value in the treatment of phthisis. He trusted that these results would afford a glimpse at some of the fundamental laws of the system.

ROYAL SOCIETY.

Thursday, February 10th, 1859.

Sir Benjamin Brodie, Bart., President, in the Chair.

EXPERIMENTS ON THE ACTION OF FOOD UPON THE RESPIRATION. BY E. SMITH, M.D., LL.B.

The method adopted by Dr. Smith was as follows:—First, to take the food under examination apart from the influence of other food, and therefore before any meal had been taken; secondly, to take about the quantity usually taken by mankind; thirdly, to ascertain the amount of carbonic acid expired and of air inspired, with the rate of respiration and pulsation, in a state of perfect rest and in the sitting posture, immediately before the food for examination was taken, and to compare all results obtained during the action of the food with this basis quantity; and, fourthly, to make an inquiry in from three to ten minutes after taking the food, and to repeat it every twelve or fifteen minutes until the maximum influence was obtained, the conditions as to posture and quietude remaining unbroken. He showed, from the hourly variations of these phenomena of respiration, that such an inquiry could not be made correctly between the meals, on account of the incessant variations then occurring from the meals (a source of error in the results obtained by Böcker and other observers); nor in the evening, since at that period all the phenomena declined; and that only in the morning, before breakfast, and before the usual breakfast hour, could trustworthy results be obtained. He also showed that the influence of food is evident soon after its introduction into the system, and attains its maximum within about two hours. The persons experimented upon were chiefly himself and Mr. Moul; but Professor Frankland, F.R.S., Mr. Hoffman, of Margate, and Mr. Reid, of Canterbury, had also submitted themselves to the inquiry.

The substances investigated were very numerous, and the experiments exceeded two thousand. The following is a list of the foods described in this communication:—

1. *Starch series:* arrowroot, arrowroot and butter, arrowroot and sugar, commercial starch, wheat starch, gluten, bread, oatmeal, rice, rice and butter, potato and gum. 2. *Fats:* butter, olive oil, cod-liver oil. 3. *Sugars:* cane sugar, grape and milk sugars, cane sugar with acids and alkalies. 4. The *milk series* (cows): new milk, skimmed milk, casein and lactic acid, lactic acid, cream, sugar of milk and lactic acid. 5. *Alcohols:* spirits of wine, brandy, whisky, gin, rum, sherry and port wine, stout, ale. 6. The *tea series:* tea, green and black, hot and cold, in different quantities, and with acids and alkalies, coffee, coffee-leaves, chicory, and cocoa. 7. *Other nitrogenous substances:* gelatin, albumen, fibrine, almond emulsion.

The following are a few of the principal results:—

1. Pure starch and fats do not increase the quantity of carbonic acid evolved; but, on the contrary, the latter somewhat lessen it.

2. These substances are either not found alone in nature, or they are not used alone as food, but are associated with other substances which tend to call them into action, and which constitute a class which the author has termed "respiratory excitants".

3. The cereals—viz., wheat-flour, oatmeal, and rice, containing besides, starch, albuminous products, gluten, and sugar, have a great and enduring power in increasing the production of carbonic acid, an increase exceeding two grains per minute, and continuing upwards of two hours.

4. Milk in its natural combination, and in each of its elements, excites the respiration to an extent from new milk of nearly two grains of carbonic acid per minute. Lactic acid had the least influence, and then cream, but cream had more influ-

ence than butter. No artificial combination of the elements of milk produced the effect of the natural milk. Milk produces its effects in different degrees in those who like and those who do not like it.

5. Sugars are most rapid and powerful respiratory excitants, so that an ounce and a half of cane-sugar gave an increase of about two grains of carbonic acid per minute in less than half an hour. The addition of acid usually increased the maximum, whilst tbat of alkalies increased the duration of its influence. Milk sugar had less influence than cane sugar, and grape sugar less than either; but the latter still produced an increase of more than one grain of carbonic acid per minute. Thus of the hydro-carbons, sugar must be classed apart from starch and fat.

6. Tea and coffee are powerful respiratory excitants, producing an increase of from one and a half to three grains of carbonic acid per minute, and an effect which endured upwards of one hour. Acids added to tea rendered it more stimulating, and alkalies made it more soothing, but a fixed alkali destroyed its influence. Chicory and cocoa have a similar but less powerful action, whilst coffee-leaves caused a diminution in the exhalation of carbonic acid of one grain per minute.

7. Alcohols differ in effect both in the different members of the class and in different specimens of the same kind. Alcobol always increased the evolution of carbonic acid to the extent of less than one grain per minute. Rum, also, commonly had the same result; and good malt liquors produced an increase sometimes exceeding one grain per minute, and enduring more than two hours. Sherry wine commonly gave a small and sustained increase. Brandy and gin, and particularly the latter, lessened tbe quantity of carbonic acid evolved, whilst whisky varied witb the different specimens. The inhalation of the volatile elements of alcohol and spirits and wines caused a diminution in the quantity of carbonic acid, and an increase in the vapour exhaled by the lungs. These various members of this heterogeneous class differ greatly in the amount of alcohol which they contain, as well as in their other elemeuts—as sugar, gluten, acids, salts and volatile oils, and ethers—and, in the author's opinion, should not be classed together.

8. Gelatin, albumen, and fibrine, also increased the production of carbonic acid to a maximum quantity less than one grain per minute.

9. Thus nearly all nitrogenous foods are respiratory excitants.

10. Foods may be thus classed in reference to this latter quality: *Non-excitants*—starch, fat, some alcohols, coffee-leaves; *Excitants*—sugar, milk, cereals, potato, gluten, casein, gelatiu, fibrine, albumen, tea, coffee, cocoa, chicory, alcohol, rum, ales, and some wines.

The author did not discuss the mode in which they produce these effects; but he adduced several facts which may aid in forming an opinion upon the subject. He also stated that whenever there was an increase in the quantity of carbonic acid evolved, there was also an increase in the quantity of air inspired; but that these were not due to increased *rate*, but to increased *depth* of respiration. He also fouud that the same food produced effects differing in *degree* in different persons, and in the same person at different periods; and such was also the case with the action of acids and alkalies upon the human system.

Professor Frankland bore testimony to the efficiency of the apparatus and the method employed by the author: and stated the great exactitude with which an observer could make iuquiries after a little practice. He thought that the time had not arrived wheu we could determine with certainty the mode of action of foods; but he was of opinion that the author, by his very extensive and laborious inquiries, had greatly facilitated the efforts of future observers, and had done good service to physiological chemistry.

Dr. Carpenter expressed an opinion as to the cause of the inaction of starch, when taken alone, in accordance with the results obtained by the author on the action of gluten; and, referring to the large amount of hydrogen and oxygen contained in fats, explained that when the author had used the term "respiratory phenomena" in describing the results, he meant to limit himself to the carbonic acid, and not to include the formation of water.

Professor Sharpey stated that the author intended to determine the whole amount of oxygen consumed; but had not at present decided upon the most suitable kind of apparatus for that purpose. He also referred to the corroboration which this paper affords of the results obtained two years ago on the quantity of air inspired in reference to the different action of brandy and rum, which were read before the Royal Society; and showed that we are all conscious of difference in the effects of alcobols, whilst the chemical differences had not been hitherto well ascertained hy chemists. He also showed the great importance of attending to minute differences, and illustrated his remarks hy a reference to the recent hrilliant experiments in electricity by Mr. Gassiot. He thought that, as physiologists, tbey were under obligation to the author for having given his results to the Society; and, in answer to Dr. Carpenter's observation, that experiments were required upon a larger number of persons, stated that the Society would he glad to learn, in a future communication, that that learned physiologist had submitted himself for experiment.

After a few observations by the President, and the thanks of the meeting given to the author, tbe Society adjourned.

ROYAL MEDICAL AND CHIRURGICAL SOCIETY.

Tuesday, May 10th, 1859.

F. C. Skey, Esq., F.R.S., President, in the Cbair.

PRACTICAL DEDUCTIONS FROM AN EXPERIMENTAL INQUIRY INTO THE INFLUENCE OF FOOD. BY E. SMITH, M.D., LL.B., ETC.

The author, in some preliminary remarks, referred to the large amount of vital action which is necessary to maintain life, and mentioned the various circumstances which he had noted during the continuance of a prolonged fast. He stated that the practice of administering arrow-root, or other fashionable foods, consisting of starch, with water, under the impression that it was more nutritious and easier of assimilation than wheat-flour, was indefensible, since it did not sustain the vital action to a degree capable of maintaining life; and that Nature has not provided starch, as food, altogether apart from nitrogenous substances. He contrasted the action (or rather want of action) of starch with that of the cereals, and showed that the latter is nearly as great as that of any substances with which we are acquainted. He drew the distinction hetween an action which increases the existing amount of vital force, and that which only tends to prevent loss of vital power—two circumstances which, in practice, are commonly confounded; and showed that heef-tea, wines, and hrandy, can act only in the latter mode, whilst the cereals act in tbe first named manner. Hence, in cases of prolonged exhaustion, where there has long been more waste than supply, the former is not sufficient, and it is essential that the cereals be added or substituted.

The action of milk is exceedingly analogous to that of the cereals, both in extent and duration; and the comhination of tbe two appeared to be the most perfect kind of food. The casein is to the milk what gluten is to bread; and the oil in milk is associated with substances (respiratory excitants) which call it into action in a manner quite analogous to the common combination of hread and butter, or of a mixture of fat and lean flesh. He showed that milk and flesh are the best and most natural modes of exhibiting fat, and altogether preferable to the administration of separated oils. He referred to the frequent use of skimmed milk in Germany as a medicinal agent, and of sour milk in Greece and America as a part of food; and explained the action of the former by its casein and sugar as respiratory excitants, and that of the latter by the advantage of administering lactic and other acids in that combination in the summer season, and at other times when the blood, by tending to undue alkalinity, is less capable of carrying on the oxygenating process. He showed that, in fevers, skimmed milk is preferable to new milk.

As fats lessen the respiratory changes, they ought to be, and are, combined with other articles of food which increase them. He referred to the importance of determining the reasons for the administration of hotb fat and starch, and showed that there is less difference in the relative amount of these two substances used in different climates, than has been commonly helieved. He attached importance to the physical properties of fat, and explained the beneficial action of that substance when applied to the skin by its power to retard the conversion of the fluid perspiration into vapour, and thereby to lessen the waste of heat by the skin. He thought this latter mode of employment of fat to be especially fitted for cases of debility with lessened appetite and perspiring soft skin, in whom the waste is always greater than the supply.

The beneficial action of sugar was insisted upon; and the love of the French for sugar and water was explained hy the refreshing coolness, the innocuousness and tbe agreeable

flavour of the fresh made beverage, and the great freedom and lightness of respiration which attends its action. He thought the ill effects of sugar in the healthy system had been exaggerated.

The action of animal substances in increasing the respiratory process, in addition to the supply of plastic materials, was dwelt upon, and shown to be of great value to the system. These are allied to gluten, and some of them probably act as ferments; and, in illustration, he especially cited cheese, which promotes digestion if taken in small quantity, but is apt to disturb it if much is eaten.

Tea was shown to cause increased waste, and to excite every function of the body; and hence was well fitted to cases where there was a superfluity of material in the system, or where we otherwise desire to induce a temporary increase in the vital action; but is injurious in those who are under-fed, or in any case where there is greater waste than supply: and, in illustration, cited the increase in the loss of weight of the prisoners at Wakefield when tea was added to their food. The action of tea had been hitherto misunderstood; but the sagacious observation of Liebig, as to its analogy with the active principle of the bile, was much commended. He recommended its use, instead of spirituous liquors, by soldiers on march, or otherwise exposed for a lengthened period to great heat; since, by its powerful influence in increasing respiration and the action of the skin, without increasing pulsation, it was particularly fitted to counteract the influence of heat in its tendency to induce "heat-apoplexy", or, as more suitably termed by Mr. Longmore, "heat-asphyxia". Twenty-five grains of tea, in a concentrated cold infusion, taken every hour or half-hour, during exposure, would suffice. For similar reasons, he urgently recommended it as an adjunct in the treatment of suspended animation, as from immersion. It has a rapid and accumulative action, so that small and repeated doses have much greater effect than large and isolated ones. It differs from coffee chiefly by increasing the action of the skin, and thereby tending to cool the body; and therefore the two substances are applicable to different conditions of the system. He thought that both, and particularly tea, ought to be more commonly used as medicinal agents. Coffee-leaves he believed to be a valuable febrifuge medicine, and one particularly fitted for cases of nervous excitability.

The author then contrasted the effects of brandy and gin with tea, and showed that in all respects they were directly opposed; but coffee so far resembled them in action, that it lessened the action of the skin, and thereby lessened refrigeration. Rum and beer he regarded as restoratives, and the combination of rum and milk as the best restorative employed as food; whilst brandy and gin simply lessened waste. He regarded all alcohols as having their chief influence in sustaining the action of the heart; and recommended that they should be given in small quantities, and repeated every quarter or half hour in urgent cases, so as to accumulate their action, rather than allow reaction to follow each dose by permitting a long interval between the doses. He mentioned a case in which he gave six bottles of port wine in forty-eight hours, with the effect of saving the patient's life, and reducing the pulse from 150 to 90 per minute. He believed that alcohol increased the respiratory action indirectly through the nervous system; and that, in fine old wines and spirits, the action is lessened by the volatile elements, which have a conservative tendency. He particularly cited the conservative influence of fine old port wine, and the disturbing influence of new and inferior spirits. The primary and secondary action of all alcohols, when taken in an amount to affect the sensorium, was always felt; and the author described the attendant circumstances.

In conclusion, the author stated that dislikes for food are indicative of lessened action, and that other foods of analogous properties should be provided in such cases; and also that it was probable that at least some kinds of azotised substances are more fitted for the hot season, when the chemical changes are greatly reduced, than has been heretofore believed.

NATIONAL ASSOCIATION FOR THE PROMOTION OF SOCIAL SCIENCE.

[*Held in Liverpool, Monday, October 11th, 1858, and following days.*]

The Earl of Carlisle, K.G., President, in the Chair.

CONTRIBUTIONS TO A NEW SCHEME OF DIETARY FOR COUNTY PRISONS. BY EDWARD SMITH, M.D., LL.B.

Dr. Edward Smith gave a practical application of some of his experiments.

In the English gaols, there is a different dietary for county prisoners and for convicts, the latter being usually much in excess of the former. The government has provided a scheme for county prisoners, but has not compelled the magistrates to adopt it; so that, in one-half of these gaols, there is still no uniform scheme of dietary. The author's attention was chiefly directed to the government scheme, and he showed it to be based upon wrong principles, and unjust in its details. (See *Transactions* of the Society for the Promotion of Social Science, 1858; and the *Dublin Medical Quarterly Journal*, May 1859.) Increase of food with duration of imprisonment is unnecessary, provided the prisoners are supplied with sufficient food from the commencement. Variation in the quantity of nutriment from day to day (the conditions being unchanged) is absurd; and the allowance of one pint of soup per week, as a distinction between no labour and hard labour, is manifestly ridiculous.

The chief defects in the existing scheme are, the deficiency of food in short, and excess of food in long imprisonments; and the apportionment of one, and that an insufficient, amount of food to all kinds of hard labour. It is upon these two points that the author has prosecuted a series of experiments.

In the existing scheme, the amount of food supplied varies through five classes from one pound of bread and four ounces of oatmeal daily for the shortest sentences, to twenty-two ounces of bread and one pound of potatoes daily, four ounces of oatmeal four times and two ounces thrice per week, a pint of cocoa thrice per week, with four ounces of cooked meat without bone four times, and three ounces thrice per week, in the sentences of four months and upwards.

The author adopted the dictum of Sir James Graham, in his letter of instructions to the Commissioners, that the dietary shall not be made an instrument of punishment; and proceeded to state what is the true amount of food required under different circumstances. He discarded the basis of duration of imprisonment, and adopted that of the degree of labour enforced. He suggested that four classes should be established—1. For all cases without labour; 2. Those with light labour, as in ordinary manufactures and trades; 3. In the heavy manufactures, as weaving wide widths of cocoa-matting, and with the use of the lighter cranks and the shot-drill; and 4. With the full pressure of the crank and the treadwheel labour.

In the first classes, he found, as the result of eight experiments, that eight ounces of carbon and two hundred grains of nitrogen are lost by the system daily (he has not yet determined the amount of hydrogen consumed); and that, in the other classes, the addition is one-fifth, three-fifths, and four-fifths of that quantity, respectively. From this he deduced the amount of food which must be supplied to meet this waste; and, taking bread and cheese as offering a good basis for comparison, the quantities required in the four classes are as follows:—

1. In rest, twenty-three ounces of bread and two ounces and a quarter of cheese.
2. With light trades, twenty-seven ounces and a half of bread and three ounces of cheese.
3. With heavy trades and light crank labour, thirty-six ounces and three-quarters of bread and four ounces of cheese.
4. Full treadwheel and crank labour, forty-one ounces and a half of bread and four ounces and a half of cheese.

On this plan, a dietary is provided which meets the wants of each man separately, and which is adapted to every prison, notwithstanding the extraordinary diversity which, in his former paper, printed in the *Transactions* of this Association, 1858, and in the *Philanthropist*, 1858, he has proved to exist in prison discipline.

The author then stated the proportion which other ordinary articles of food bear to bread and cheese, so as to enable any one to vary the kind of food, and yet retain the due proportion of nutritive elements. This is given in the following table, chiefly compiled from Playfair's table, which shows the propor-

tion of carbon contained in various articles of food, as compared with that in ten parts of bread, the quantity of nitrogen contained in each ounce avoirdupois, and the cost per pound at the present contract prices.

	Parts of various substances equal in carbon to 10 parts of fresh bread.	Nitrogen in each oz. — Grains.	Cost per lb. Oct. 1858. — s. d.
Bread		5¾	11-12
Wheat flour	8	7¾	1¼
Peas	8	15¾	1½
Rice	8	4⅓	1½
Oatmeal	7½	8¾	1½
Scotch barley	—	—	1⅝
Molasses	—	—	2
Meat (fresh)	10	8¾	4½
Cocoa	5	8¾	1 1½
Potatoe	½	1½	¾
Suet or butter	4½	—	
Sugar	7½	—	4½
Indian corn	7½	7¾	
Cheese	8	19½	6

This table is equally applicable to workhouse dietary.

Dr. Smith then described the influence of certain modifying circumstances, determined in part by his own labours, and in part by the observations of Mr. Milner, surgeon to the Wakefield County Gaol, given in a paper recently read before the British Association. These are age, sex, size, season, conformation, and employment. Mr. Milner showed, in reference to age, that a dietary better than that of the highest class in county prisons was excessive in old age, whilst it was insufficient to maintain the due growth of the body at the age of seventeen. Persons of unusual height, and of a girth of thirty-four inches and upwards, lost weight in a rapidly increasing ratio. The duration of imprisonment had no marked influence. In reference to the waste of carbon by the treadwheel labour, the author proved that, with a quarter of an hour's work, the increase over that of the state of rest was more than five times; and, with alternations of work and rest during seven hours and a half, it was three times.

In reference to seasons, Dr. Smith proved that the system is at its lowest state of vital action at the end of summer; and Mr. Milner showed that his prisoners gain weight from May to September, and lose during the other months.

The general regulations recommended by the author were as follows:—

1. The supply of food must meet the wants of the system.
2. Variations in quantity of nutriment with duration of imprisonment, and from day to day, are unnecessary.
3. Growing persons must have a sufficient excess of food to maintain the development of the system, whilst to old persons less food may be supplied.
4. From December to the end of May, the quantity of food should be one-sixth greater than from the end of June to the end of September.
5. Those of unusual height and size must receive a large proportion of food from the commencement of the imprisonment.
6. The supply must vary day by day with the labour exacted. The breakfast should be as good a meal as the dinner, and especially with hard labour; and the treadwheel should not be worked before breakfast.
7. The meals should not be too bulky, so as to impede respiration with hard labour.
8. Other things being equal, the cheapest articles should be preferred; and hence potato should be supplied more sparingly, and peas more plentifully. He commended the use of unsifted flour, ground and made into bread, under efficient superintendence, in the prison.

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